WEST POINT LAKE PREDICTIVE CHLOROPHYLL*a* MODELING REPORT

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REFERENCE: Proceedings of the 1991 Georgia Water Resources Conference, held March 19 and 20, 1991 at The University of Georgia. Kathryn J. Hatcher, Editor, Institute of Natural Resources, The University of Georgia, Athens, Georgia 1991.

INTRODUCTION

The Environmental Protection Agency (EPA), in 1986, initiated a water quality assessment of West Point Lake on the Chattahoochee River near LaGrange, Georgia. The EPA Region IV Environmental Services Division (ESD) evaluated the existing water quality condition of West Point Lake and the effects of the upstream nutrient loads on the system. Based on July, August, and September 1986 water quality data collected, water quality problems such as high levels of nutrients and high levels of chlorophyll*a* were observed (EPA 1987). Additional data were collected in 1987, through a joint Georgia Department of Natural Resources (GaDNR) and EPA study (GaDNR 1987). These data confirmed the existing water quality problems.

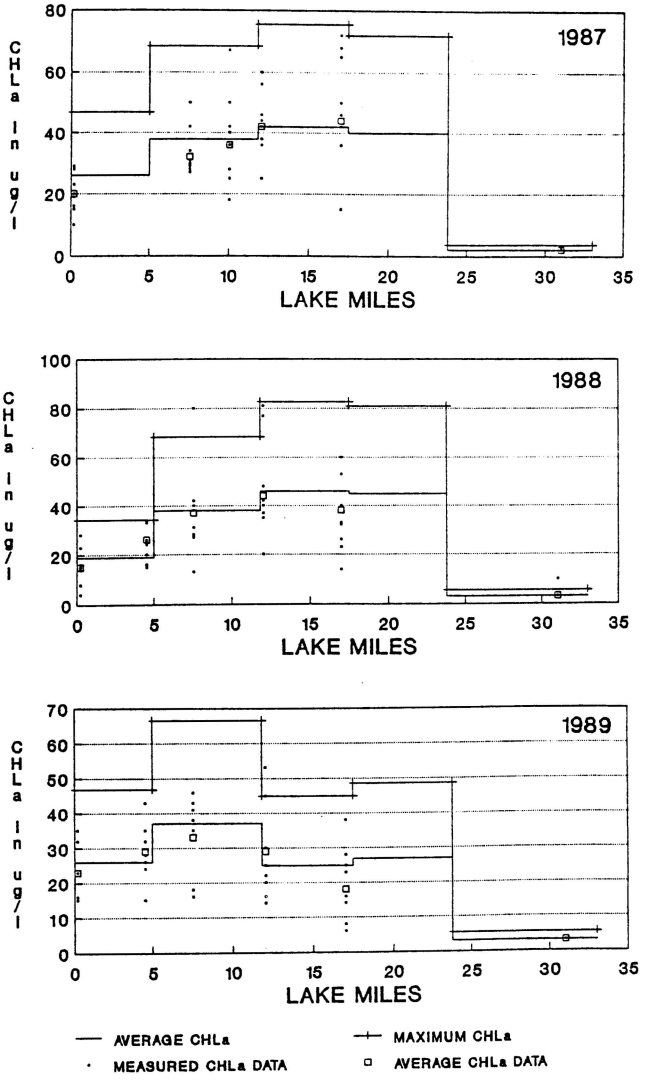
Evaluation of the 1980 to 1989 nutrient and chlorophyll*a* data shows these values have increased over this period and would continue to do so unless increases in upstream nutrient loadings are curtailed.

LAKE MODELING

In 1988, EPA contracted with the COE Waterways Experimental Station (WES) to apply the Lake model BATHTUB and the data reduction programs FLUX and PROFILE to analyze the nutrient inputs to West Point Lake and the resultant Lake responses (Gaugush 1988). Based on the water quality data, the algal assays and the modeling results it was concluded that the limiting nutrient into West Point Lake is nitrogen and that a reduction of nitrogen inputs or a substantial reduction of phosphorus inputs are needed to reduce inlake chlorophyll*a* concentrations.

The West Point Lake model was further calibrated and verified by EPA using the complete growing season set of 1987, 1988 and 1989 lake water quality data. In the EPA analysis, the original BATHTUB model phosphorus, nitrogen and chlorophyll*a* calibration factors, utilized by WES, were adjusted from the original WES model, to better represent the actual phosphorus, nitrogen and chlorophyll*a* levels measured in the Lake.

The 1987-1989 model results indicate the West Point Lake model does a good job of predicting lake chlorophyll*a* levels under low and average flow conditions and varying nutrient loads. Figures 1 - 3 illustrate the model's chlorophyll*a* predictive capabilities during West Point Lake's 1987-1989 growing seasons.



Figures 1-3. Model Predictions for Chlorophyll*a* in West Point Lake for April-October 1987, 1988, 1989.

The West Point Lake model was then used to evaluate what impact nutrient reduction alternatives will have on the Lake's chlorophyll*a* levels. Since the majority of nutrients going into West Point Lake are from point sources and point source phosphorus reduction is a more viable and inexpensive option than nitrogen reduction, this was the only alternative examined.

As previously stated, under existing nutrient loading conditions, West Point Lake is nitrogen limited. In order to drive the Lake to a situation where phosphorus reduction will have a significant impact, the headwater's phosphorus load will have to be reduced from the 1989 loading of 7000 #/day to under 2000 #/day. The 2000 #/day loading is the approximate point where phosphorus becomes the limiting nutrient and reducing the phosphorus loads to this point will significantly reduce the Lake chlorophyll*a* levels. Figure 4 illustrates the Lake's predictive lake-wide mean chlorophyll*a* response to reduced levels of headwater phosphorus loadings under an average flow and a ten year low flow condition.

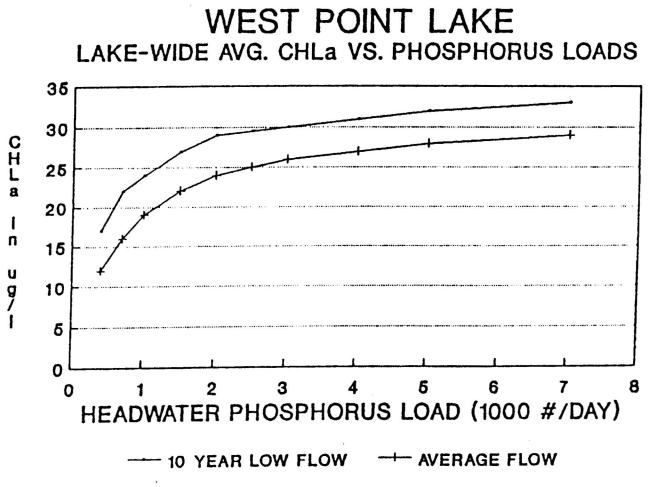


Figure 4.

NUTRIENT SOURCES

The background nonpoint nutrient sources contributing to West Point Lake nutrient load are mostly from urban and forested land and were estimated from available STORET water quality data. Other nonpoint sources, such as CSOs, stormwater runoff and urban nonpoint source phosphorus contributions have been previously estimated to be approximately 2000,000 kg/year (GaDNR 1989). The total nonpoint source phosphorus contribution accounts for a load of approximately 700 #/day or approximately ten percent of the yearly total phosphorus load to West Point Lake. Therefore, a reduction in nonpoint source phosphorus loads will not have as significant an impact as a reduction in point source phosphorus loads.

The upstream Atlanta-area waste treatment facilities (WTF) point source loadings contribute the major portion of the nutrient inputs to West Point Lake. For 1986 - 1989, point sources contributed over 7000 #/day of phosphorus to West Point Lake.

The Atlanta area WTF design flow upstream of West Point Lake has been established at 358 mgd with present WTF flows at 275 mgd. Using the design WTF flows, the headwater phosphorus load to West Point Lake can be projected for various WTF phosphorus control alternatives.

LAKE CRITERIA

The next step in the Lake evaluation process, is the selection of an appropriate West Point chlorophyll*a* goal or criteria. The factors in determining the appropriate chlorophyll*a* level are; 1) the protection and enhancement of recreational uses; 2) the promotion of good fisheries and aquatic life and 3) the provision for a safe drinking water supply (Bayne 1983, EPA 1974, National Academy 1983, Walker 1983).

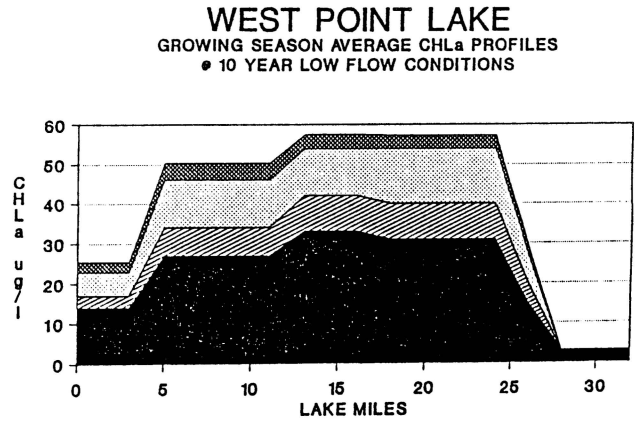
To establish a healthy West Point Lake in which both fishing and recreational uses and a safe drinking water supply can be maintained, the following chlorophyll*a* criteria should be met:

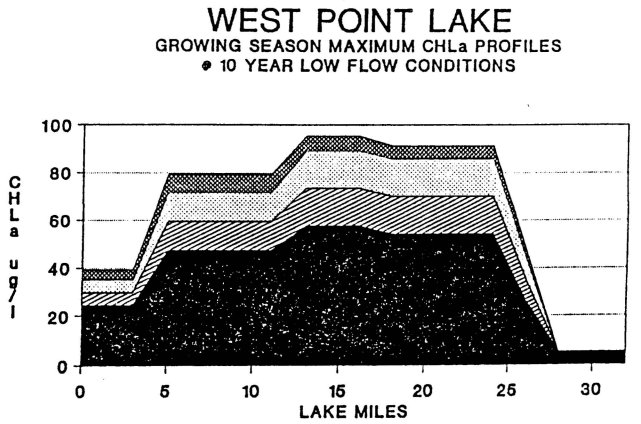
- A growing season average lake-wide chlorophyll*a* of 15 to 20 ug/l for average and 10 year flow conditions.
- A maximum chlorophyll*a* of around 50 ug/l for low flow conditions and 40 ug/l or less for average flow conditions.
- A LaGrange water intake growing season average chlorophyll*a* equal to or less than 27 ug/l for average flow conditions.

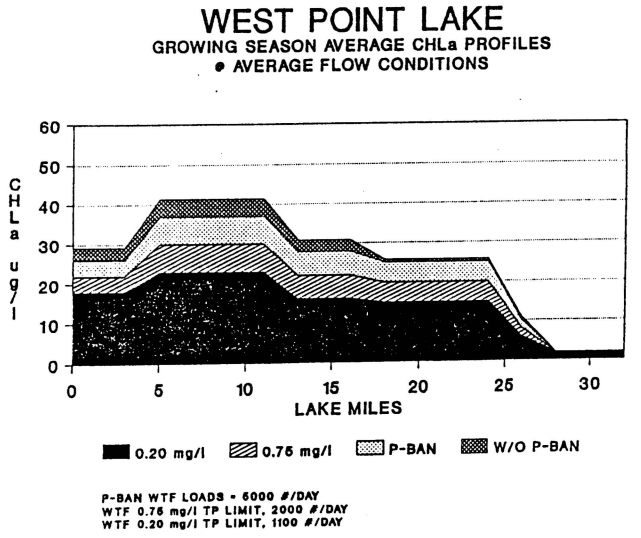
Three phosphorus reduction alternatives and their respective water quality benefits were examined. For these alternatives the point source phosphorus concentrations were calculated using the design WTF flow of 358 mgd. The alternatives are:

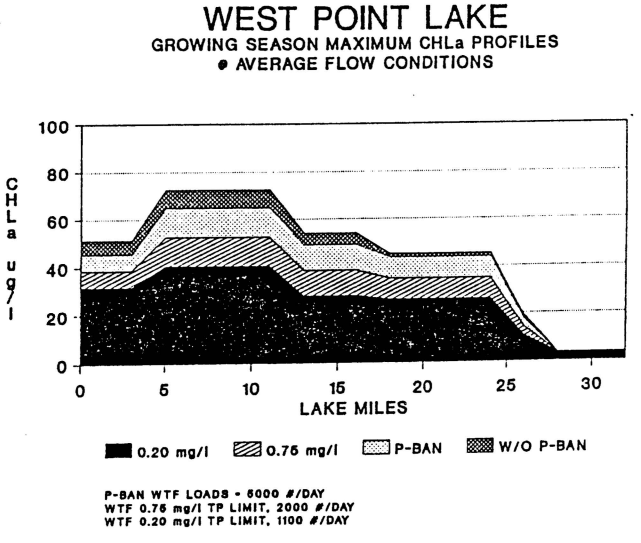
- Detergent phosphorus ban only, yielding a resultant West Point Lake headwater loading of 4100 #/day.
- A point source effluent limit of 0.75 mg/l yielding a resultant West Point Lake headwater loading of 2000 #/day. This can be achieved by chemical addition and additional clarifiers at an estimated additional treatment cost of $75,000 per year per mgd of wastewater.
- A point source effluent limit of 0.2 mg/l yielding a resultant West Point Lake headwater loading of 1100 #/day. This can be achieved by chemical addition, additional clarifiers, and effluent filters, at an estimated additional treatment cost of $100,000 per year per mgd of wastewater.

Figures 5 - 6 compare the predictive inlake chlorophyll*a* results of these alternatives to each other and to the average 1986 - 1989 point source loads (7000 #/day) for









Figures 5 - 6.

Figures 7 - 8.

the growing season mean chlorophyll*a* under both the average (Fig. 5) and 10 year low flow (Fig. 6) conditions. Figures 7-8 show similar information for the predicted maximum chlorophyll*a* concentrations.

To best meet the West Point Lake proposed criteria, EPA recommended that a headwater phosphorus Total Maximum Daily Load of 1100 #/day be established. This translates into an Atlanta area point source phosphorus wasteload allocation of 0.2 mg/l at the future 358 mgd wastewater design flow. The additional cost for treatment to this level is projected to be $100,000 per year per mgd of wastewater.

CONCLUSIONS

The detergent phosphorus ban by itself will not result in significant water quality improvements. Comparing the phosphorus ban results to 1988 phosphorus loads and chlorophyll*a* levels, only a 4 percent reduction on West Point Lake chlorophyll*a* levels projected. However, in conjunction with other WTF phosphorus reduction alternatives, the phosphorus ban will result in less sludge production and lower treatment cost than if no phosphorus ban was in effect. WTF effluent data for the first three months of 1990 indicate that the point source phosphorus loads have been reduced from 7000 #/day in 1988 to 4200 #/day in 1989, primarily due to the phosphorus ban.

The 0.75 mg/l phosphorus effluent level will improve the water quality in West Point Lake. Comparing the 0.75 mg/l phosphorus limit results to 1988 phosphorus loads and chlorophyll*a* levels, a 20 percent reduction in West Point Lake chlorophyll*a* levels is projected. However, the average flow maximum chlorophyll*a* criterion of 40 ug/l or any of the low flow chlorophyll*a* criteria are not met.

The 0.2 mg/l phosphorus limit will significantly improve water quality in West Point Lake. Comparing the 0.2 mg/l phosphorus limit results to 1988 phosphorus loads and chlorophyll*a* levels, a 30 percent reduction in

West Point Lake chlorophyll*a* levels is projected. This will meet the growing season average chlorophyll*a* criteria targets except for a ten percent exceedance of both the low flow maximum chlorophyll*a* level and the low flow LaGrange water intake chlorophyll*a* target levels.

The additional effluent filtration needed to meet this 0.2 mg/l limit will also result in additional removal of BOD, fecal coliform, metals, and other toxic substances resulting in additional water quality benefits for the Chattahoochee River and West Point Lake. It should also be noted that at this level of treatment, CSOs, stormwater point sources, and non-point sources combine to represent over 50 percent of the phosphorus load to West Point Lake. Phosphorus reduction strategies involving these sources would be important to pursue.

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